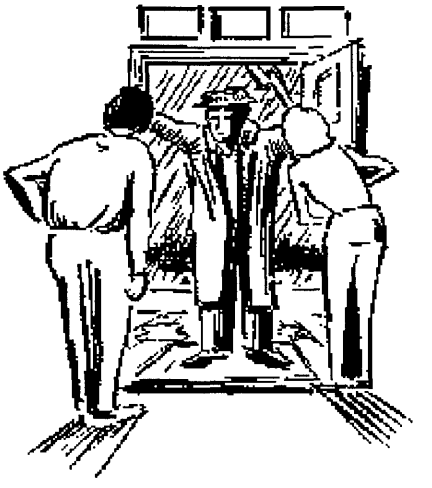
3 Natural Hazards: Applying the Four Phases

In this unit, you will learn

- Definitions of major natural hazards,
- Signs and warnings of each natural hazard,
- Immediate and long-term dangers posed by each natural hazard,
- Mitigation, preparedness, response, and recovery measures that are appropriate for each natural hazard, and
- Related emergencies that can follow in the event of an emergency involving a particular natural hazard.

The largest single category of repetitive threats results from weather or geological events that can affect any area of the country. Their impact can be localized or widespread, predictable or unpredictable; resulting damage can range from minimal to major. Depending on the severity of the incident, they can have a long-term impact on the infrastructure (roads, bridges, and utilities) of any given location. Threats involving natural forces include dam failure, drought, earthquake, flood, hurricane, landslide, tornado, tsunami, volcano, wildfire, thunderstorm, and winter storm.

Natural hazards are more predictable than any other type of hazard. Although we cannot know exactly when they will occur, precisely where they will strike, or how severe they will be, we do recognize from past experience which geographical areas are most vulnerable to certain types of natural hazards. This knowledge helps to better prepare for and respond to natural hazards.



Floods, hurricanes, and thunderstorms are common examples of natural hazards.

Warnings for natural disasters are usually issued by a Federal agency and announced over the radio or television. *Mitigation* measures can be taken to increase the safety of your home. You also can determine what kind of damage your home is likely to suffer. For some disasters, response will include finding *shelter* in your home. For others you will *evacuate* to a shelter outside of the threatened area. *Recovery* will include assessing the damage, filing a claim with your insurance company, and repairing the damage. If the disaster is severe, you may be eligible to apply for governmental assistance.

As you read through the following fact sheets on natural hazards, remember that each type of hazard has unique characteristics. These characteristics permit you to prepare and protect yourself. Learn them. Know how to protect yourself and your home from the natural hazards that threaten you, and know how to respond safely to all natural emergencies, particularly those most likely to occur in your geographical area.

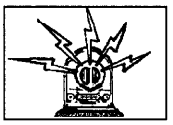
Natural hazards are more predictable than any other type of hazard. Knowledge of past events can give clues to whether a community may be vulnerable to certain kinds of natural hazards.

Thunderstorms **are a violent form of convection. Convection is a process in which cold upper air sinks and warm, moist air rises. As the warm air rises, storm clouds called *thunderheads* develop. These clouds make thunderstorms that bring strong winds, lightning, hail, and rain. *Lightning*, the discharge of electricity within the storm cloud, always accompanies a thunderstorm.**

Thunderheads may be miles across at the base and reach heights of 40,000 feet or more. They can dump large amounts of rain or hail on localized areas. Violent lightning can strike the ground several miles away from its parent cloud. In addition, tornados and flash floods can be caused by thunderstorms.

There are at least 100,000 thunderstorms annually across the United States. Statistics show that an average of more than 100 people are killed and about 250 injured each year by lightning. Annual property loss is estimated in the hundreds of millions of dollars.

At any given moment, nearly 2,000 thunderstorms are in progress over the earth's surface. Their frequency and potential for violence make them one of nature's greatest killers and destroyers.



SIGNS AND WARNINGS

- Lightning, thunder, and storm clouds occur together. Dark, towering, or threatening clouds are the first indication of possible thunderstorms. Distant lightning and thunder is another sign. Because light travels so much faster than sound, lightning flashes can be seen long before the resulting thunder is heard. To estimate how many miles away a thunderstorm is from your area, count the number of seconds between a flash of lightning and the next clap of thunder, and then divide by five. For example, if there are 10 seconds between the lightning flash and thunder, the storm is two miles away (10 seconds divided by five).

- Because thunderstorms may occur singly, in clusters, or in lines, it is possible that several thunderstorms may affect you in the course of a few hours.

- The National Severe Storms Forecast Center in Kansas City, Missouri, issues severe thunderstorm watches. Local National Weather Service offices issue warnings and statements about severe weather and localized storms.

- A *severe thunderstorm watch* means that conditions are right for lightning and/or damaging winds greater than 58 miles per hour, hail that could reach a diameter of three quarters of an inch, and heavy rain.

- A *severe thunderstorm warning* means that severe thunderstorms have been sighted in your area.

IMMEDIATE DANGERS

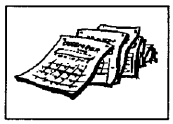
- Sudden strong winds often accompany a thunderstorm and may blow down trees across roads and power lines. In a severe thunderstorm the winds can cause extensive damage to roof and windows and may tip over mobile homes.

- Lightning presents the greatest immediate danger during a thunderstorm. In an

average year lightning kills more people in the United States than the number of persons killed from tornados, floods, and hurricanes combined.

- Flash floods and tornados can develop during thunderstorms.
- Hail can severely damage agricultural crops.

LONG-TERM DANGERS



- One or more severe thunderstorms occurring over a period of less than a week can cause extensive power outages, agricultural damage, and may lead to flooding.

MITIGATION

- Install lightning rods on all high-risk buildings. Lightning rods will carry the dangerous electrical charge of lightning bolts safely to the ground.
- Crops can be insured against loss from storm damage through the Federal Crop Insurance Corporation of the U.S. Department of Agriculture.
- Support the adoption and enforcement of a floodplain management ordinance.
- Buy flood insurance through your local property insurance agent.

PREPAREDNESS

- If you plan to be outdoors, check the latest weather forecast and keep a weather eye on the sky. When you observe signs of an impending storm—towering thunderheads, darkening skies, lightning, increasing wind—tune in your NOAA Weather Radio, AM-FM radio, or television for the latest weather information.
- If you live in a mobile home, you should make sure that it has been securely tied down to a solid foundation or ground anchors to keep the wind from shifting it or turning it over.
- Designate a safe area in or near your home to shelter your family in a severe thunderstorm.
- Teach all family members to pay attention to storm warnings and educate them on what to do in a storm if they are at home, outside, or in a car.
- Stock your shelter with candles or flashlights and with a battery-powered radio to listen to weather reports.

RESPONSE

- Do not stay in a mobile home during a severe thunderstorm.
- Get inside a storm shelter, home or large building, or inside a vehicle (but not a convertible).

SEVERE THUNDERSTORMS (continued)

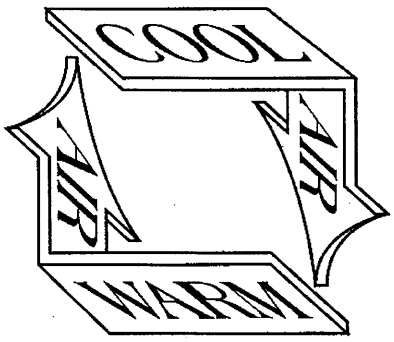
- If you are inside a home, avoid using the telephone except for emergencies.
- If you are outside and do not have time to reach a safe building or an automobile, follow these rules:
  - Do not stand underneath a natural lightning rod such as a tall, isolated tree in an open area.
  - Get out of and away from open water.
  - Get away from tractors and other metal farm equipment.
  - Get off of and away from motorcycles, scooters, golf carts, and bicycles. Put down golf clubs.
  - Stay away from wire fences, clotheslines, metal pipes, rails, and other metallic paths that could carry lightning to you from some distance away.
  - In a forest, seek shelter in a low area under a thick growth of small trees. In open areas, go to a low place such as a ravine or valley, but remain alert for flash floods.
  - If you are isolated in a level field or prairie and you feel your hair stand on end (which shows that lightning is about to strike), drop to your knees and bend forward, putting your hands on your knees. Do not lie flat on the ground.
- If you are in a car, pull safely onto the shoulder and turn on your emergency flashers until the heavy rain subsides.
- A person struck by lightning will receive severe electrical shock and may be burned; however, the individual will carry no electrical charge and can be handled safely. Give first aid and call emergency medical assistance immediately.
  - If a victim is not breathing, mouth-to-mouth resuscitation should be given immediately to prevent permanent brain damage.
  - Victims who appear only stunned or otherwise unhurt may also need attention. Check for burns, especially at fingers and toes and next to buckles and jewelry.
- More than one storm may strike an area within a few hours. Once one storm subsides, be certain there are no more storms approaching before resuming your normal activity.

RECOVERY

- Have damage to your home and property assessed as required by your property insurance company. Clean up and repair damage as soon as authorized by your insurer.

RELATED EMERGENCIES

Keep in mind that thunderstorms can cause other major natural hazards. *Tornados* and *flash floods* may be caused by severe storms. Also, lightning is a major cause of *wildfires.*



Thunderstorms originate in clouds called "thunderheads" which form in warm, moist air as it rises above cold air.

The transformation of a calm, slow-flowing river into a violent and destructive *flood* occurs hundreds of times each year in this country. Floods can be slow or fast rising. They are sometimes seasonal, as when winter or spring rains and melting snow fill river basins with too much water too quickly. *Flash floods* are usually the result of extremely heavy rain or snow and are sudden. Raging torrents rip through river beds after these heavy rains, surging well beyond the normal banks and sweeping everything before them. Houses, bridges, and boulders can be tossed and rolled by a flash flood.

No area in the United States is completely free from the threat of floods. On the average, each year more than 300,000 people are driven from their homes by floods, 200 flood-related fatalities occur, and $2 billion in total flood damages are sustained.

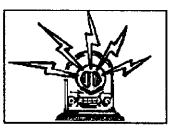
The worst recorded flood in terms of loss of lives was the 1889 flood in Johnstown, Pennsylvania, which resulted in the loss of more than 2,200 lives. The flood itself was actually caused by the failure of a dam upstream from Johnstown. This flood is a classic example of the secondary effects that can occur from another event. The worst economic losses were incurred in the 1972 floods that resulted from Hurricane Agnes ($4.7 billion) and the 1973 flood of the Mississippi River system ($1.2 billion).

Proper land use management and strict enforcement of building codes, with special attention to floodplains, has helped reduce some of the high cost of losses due to flooding. Special flood hazard areas for some 18,000 communities are identified on a Flood Hazard Boundary Map or a Flood Insurance Rate Map issued by FEMA. Many maps provide base flood elevations. Every community participating in the National Flood Insurance Program (NFIP) is required to maintain a repository for their flood maps.

The NFIP is a Federal program enabling property owners to purchase flood insurance. FEMA administers the NFIP in communities throughout the United States. The NFIP is based on an agreement between local communities and the Federal government which states that if a community will implement floodplain management measures to reduce flood risks to new construction and substantially improve structures in flood hazard areas, the Federal government will make flood insurance available. Communities in the NFIP must require new buildings in the special flood hazard area to be constructed so that the lowest floor will be located at or above the base flood elevation.

FEMA also provides many communities with data to help them designate a floodway. The floodway is that part of the stream channel, plus any adjacent floodplain land, that must be reserved in order to allow the discharge of the base flood ("100-year flood") without increasing flood heights. In other words, *no development or encroachment*, including buildings, fill, mining, dredging, or grading, is allowed within a designated floodway if it would increase flood elevations.

SIGNS AND WARNINGS



- Floods and flash floods almost always occur during or after a period of heavy rain or sudden snowmelt. A flood may be building in your area when you notice local

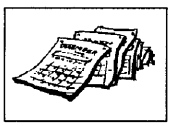
FLOOD AND FLASH FLOOD (continued)

streams and rivers flowing more swiftly and at a noticeably higher level than normal. Listen to your radio for flood forecasts.

- Flash floods occur swiftly. If you hear a flash flood warning on the radio, or hear the roar of approaching waters, act immediately. Head for the nearest high ground. Seconds may make the difference between life and death.
- Many communities have installed water gauges to help monitor water levels.
- Flood warnings are issued by the National Weather Service. Local police, the sheriff, the highway patrol, the county flood control district office, and other local agencies may also supply flood warnings.
  - A *flash flood watch* is issued when flash flooding is possible within the designated watch area: be alert.
  - A *flash flood warning* is issued when a flash flood has been reported or is imminent: take necessary precautions.
  - A *flood warning* is issued as an advance notice that a flood is imminent or is in progress at a certain location or in a certain river basin. Take precautions as directed.

IMMEDIATE DANGERS

- The immediate danger from flash floods is from the strength of the water current as it surges through an area, carrying debris and causing injuries and drowning.
- Floods can interrupt power, disable fuel sources, and make roads impassable. People may be stranded in their homes, or be unable to reach their homes.



LONG-TERM DANGERS

- Dangers include the outbreak of disease, widespread animal death, broken sewage lines and widespread water supply pollution, broken gas lines, downed power lines, and fires.
- Large-scale flooding can disrupt a community for a long time while utilities are restored, debris is cleared, and property is repaired.
- Agricultural lands can be ruined and crops destroyed by flooding.

MITIGATION

- Through the National Flood Insurance Program (NFIP), people can protect themselves from financial ruin due to property loss from floods. Ask your local property insurance agency about flood insurance.
- Avoid building in a floodplain unless you elevate and reinforce your home. Check local building codes and ordinances. While the cost of protecting your home may be expensive, the investment will save you from the potential of even costlier damage. Remember, the cherished possessions of a lifetime cannot be replaced by money.

PREPAREDNESS

- Stockpile emergency building materials such as sandbags, plywood, plastic sheeting, and lumber.
- Install check valves in building sewer traps to prevent flood water from backing up in sewer drains.
- Keep your car fueled. If electric power is disrupted, gas station pumps may be out of operation for several days.
- Make family evacuation plans. If you are in a flash flood area, have several alternate routes to ensure rapid evacuation.
- Maintain emergency supplies such as a first aid kit, water, and foods that require little or no cooking and no refrigeration. A portable radio, emergency cooking equipment, and flashlights should all be maintained in a designated area.
- Store drinking water in jugs, bottles, and pans.

RESPONSE

- As flood waters rise, take these key precautions.
  - Secure all outdoor items or store them inside on upper levels.
  - Move all valuable household possessions to upper levels away from rising floods.
  - Move cars, machinery, and all livestock to higher ground.
  - Check emergency food and water supplies—keep them high and dry.
- Listen to radio announcements from emergency officials. If you are told to evacuate, do so immediately. Use only those routes recommended by local authorities. Any other route could be blocked or otherwise made impassable by flooding.
- If there is time before evacuation, turn off all utilities at the main switch. Do not touch any electrical equipment unless it is in a dry area, or you are well insulated with rubber footwear and gloves.
- Do not attempt to drive over a flooded road; you can become stranded or trapped. If your car stalls while in flowing water, abandon it immediately. Cars may only serve as traps in the face of a raging flood.
- Do not attempt to cross a flowing stream where water is above your knees.
- In a flash flood warning, the only thing to do is *move immediately to high ground.* Because of the speed with which a flash flood travels, you have no time to save any possessions or implement any precautionary measures. Save your life by moving to high ground without any hesitation.

RECOVERY

- If your home, apartment, or business has been damaged and you have a flood

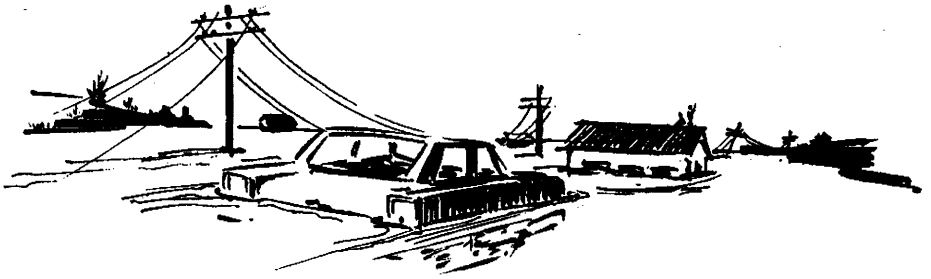
FLOOD AND FLASH FLOOD (continued)

insurance policy, immediately call your property insurance agent for advice on what you should do next to receive assistance.

- Do not use fresh food that has come in contact with flood waters. Have all drinking water tested by local health authorities before using. Wells should be pumped out and the water tested before drinking.
- Before entering a building, check for structural damage; make sure it is not in danger of collapsing.
- Open the building and let it air out for several minutes before entering to remove foul odors or escaped gas.
- Upon entering the building, do not use a match or lantern as a source of light because of the possibility of gas buildup; a battery powered flashlight is recommended. Check for electrical shorts and live wires. Make certain the power is turned off and do not use any appliances or lights until an electrician has checked your electrical system.
- Report broken utility lines to appropriate authorities.
- Open all doors and windows to help dry the building. Shovel out mud while it is still moist to give walls and floors an opportunity to dry.

RELATED EMERGENCIES

Keep in mind that floods can cause *landslides, mudflows,* and *power outages.*



If you must travel during a flood, listen to a battery-powered radio to obtain information on the safest routes. Several alternate routes should be planned BEFORE starting out on your trip.

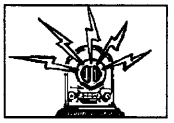
Landslides **are characterized by the downslope movement of rock, soil, or other debris. Landslides occur in all parts of the country, particularly in hilly areas that have a lot of rainfall. Frequently, they accompany other natural hazards such as floods, earthquakes, and volcanic eruptions. Landslides can occur as a result of land mismanagement. Increased housing development in landslide-prone areas will also increase potential damage if a landslide occurs.**

Landslides can occur either very suddenly or slowly. They can be triggered during earthquakes, heavy rainstorms, rapid snowmelts, volcanic eruptions, storm-generated ocean waves, or other landslides. Landslides also can result from triggers such as freeze-thaw cycles, shrink-swell cycles, root wedging, animal burrows, natural erosion or deposition, or the thaw of ice-bearing soils such as permafrost. While most landslides are single events, more than one-third of the cases are associated with heavy rains or the melting of winter snows.

The annual death rate from landslides is 25 to 50, with annual economic losses estimated at $1 to $2 billion. These extensive economic losses include not only the replacement and repair of damaged facilities, but also associated costs such as lost productivity, disruptions to utility and transportation systems, and loss of revenue for affected communities.

Mudflows **are defined as flows or rivers of liquid mud down a hillside. They occur when water accumulates under the ground, usually following long and heavy rainfalls. If there is no brush, trees, or groundcover to hold the soil, mud will form and flow down the slope.**

SIGNS AND WARNINGS



- Landslide warning signs include opening of cracks on hillslopes—evidence of slow, downhill movement of rock and soil; tilting of trees, poles, or walls; or perceptible changes such as the formation of sags and bumps in the slope.

- Mudflows are most commonly triggered by high-intensity rainstorms, but can also occur following forest fires when soil is newly bare. They tend to flow in channels, but will often spread out over the floodplain. They generally occur in places where they have occurred before.

- If you suspect a slope is unstable, have a specialist examine the slope. Possible signs of slope failure include the following:
  - Doors or windows sticking or jamming for the first time;
  - New cracks appearing in plaster, tile, brick, or foundations;
  - Outside walls, walks, or stairs beginning to pull away from the building;
  - Slowly developing, widening cracks appearing on the ground or on paved areas such as streets or driveways;
  - Underground utility lines breaking;
  - Fences, retaining walls, utility poles, or trees tilting or moving; and/or
  - Water or bulging ground appearing at the base of a slope.

IMMEDIATE DANGERS

- Immediate dangers from landslides or mudflows include injuries, fatalities, and destruction of property as rocks, mud, and water slide downhill or downstream.

LANDSLIDE AND MUDFLOW (continued)

LONG-TERM DANGERS

- Long-term, slow-moving landslides destroy many structures each year by gradual downhill movement. Once such movement begins it is very difficult to control.
- Associated dangers include broken electrical, water, gas, and sewage lines. Fires also may be started by damaged electrical wires and gas lines.
- Other long-term dangers from this hazard include the continued threat of landslides due to unstable land. Erosion from the loss of adequate groundcover could be very damaging and lead to flash flooding during periods of heavy rain or following heavy snows.

MITIGATION

- Before buying land or building on any property, check with the county land commissioner or with the local office of the U.S. Geological Survey for ground composition, drainage, and stability.
- Plant groundcover on slopes, or build retaining walls.
- Reinforce the foundation and walls of your home.
- Install flexible rather than stiff pipe fittings to avoid gas or water leaks in the event of a landslide or mudflow.
- In mudflow areas, construct channels or reinforced masonry walls to direct the mudflows around your home or buildings.
- Mudflow is covered by flood insurance policies from the National Flood Insurance Program. Buy flood insurance through your local property insurance agent.

PREPAREDNESS

- Be prepared to evacuate your home.

RESPONSE

- If you are warned of an impending landslide or mudflow, evacuate at once to stable ground.
- If you are inside a building during a landslide, stay inside and get under a desk, table, or other piece of sturdy furniture.
- If you are outside and cannot get into a sturdy building while scattered rocks and debris tumble toward you, curl into a tight ball and protect your head.
- Usually, you can survive a mudflow only by avoiding it. If you are in a valley, get out as soon as possible once you hear rumbling from upstream or feel the ground tremble. These are signs that a mudflow may be coming your way.

RECOVERY

- If a landslide or mudflow has occurred near your home, thoroughly check the foundation, chimney, and surrounding land to be sure no damage has occurred. Check for damaged gas, electrical, or water lines. Do not strike a match or attempt to turn on electricity until you are sure it is safe. Report damages to the appropriate utility companies.

- Stabilization of new land should take place as quickly as possible to reinforce against secondary slippage.

- Replanting damaged land will help tremendously in both short- and long-term recovery.

Natural Hazard:
TORNADO

Tornados **are relatively short-lived local storms. They are composed of violently rotating columns of air that descend in the familiar funnel shape from thunderstorm cloud systems. The weather conditions that tend to generate tornados are unseasonably warm and humid earth surface air, cold air at middle atmospheric levels, and strong upper-level jet stream winds. Tornados can occur anywhere in the United States during any month of the year. However, the Great Plains and Gulf Coast States experience the largest number of tornados. The greatest frequency of tornados occur in April, May, and June.**

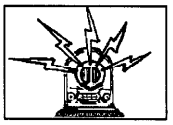
The destruction path of a tornado averages about 250 yards in width and 15 miles in length. However, in extreme conditions, a tornado may travel more than 300 miles and leave a path of total destruction more than a mile wide. Tornados will travel up to sixty miles per hour, with wind speeds approaching 400 miles per hour within the tornado's center. Tornados *usually* travel from a westerly direction to an easterly direction. However, this pattern does not apply to tornados caused by hurricanes.

Tornados occur as single storms, but sometimes several can develop at the same time. On Friday, May 31, 1985, a series of tornados ripped through eastern Ohio, western Pennsylvania, western New York, and Ontario, Canada, killing 90 persons, injuring hundreds, leaving thousands homeless, and causing hundreds of millions of dollars in damage.

Tornado warning networks are in operation in this country and help save many lives each year. Each community in high- and moderate-risk tornado areas should have a group of volunteer spotters who watch the sky during threatening weather. They should report any signs of a tornado to local emergency management officials and to the regional office of the National Weather Service.

On May 6, 1975, a tornado tore through a 200-block area of Topeka, Kansas. At least 31,000 people lived or worked in the area, which caught the full fury of the storm. While more than 2,000 homes, apartments, and businesses were destroyed, only three people died and 200 were injured because of adequate warning and quick action. An estimated 500 persons could have lost their lives in that storm had there been no warning system or if the citizens had not heeded the warnings.

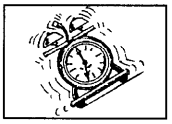
SIGNS AND WARNINGS



- Tornados develop during severe thunderstorms and hurricanes. While not all thunderstorms and hurricanes create tornados, the potential is there. During violent weather, keep tuned to a local television or radio station for tornado reports.
- If you are outside and see a funnel-shaped cloud with obvious rotating motion, it may be a tornado. As a tornado develops, it will produce a loud roar that grows louder as the funnel cloud touches the ground. When nearby, a tornado has a loud sound comparable to the combined roars of several jet engines.
- The National Severe Storms Forecast Center in Kansas City, Missouri, issues tornado watches. Local National Weather Service offices issue tornado warnings. Local officials may sound sirens in a tornado warning.
  - A *tornado watch* indicates that conditions are right for a tornado to develop and that the sky should be watched.

– A *tornado warning* indicates a tornado has been sighted or is spotted on radar. Warnings will give the location of the tornado and the area immediately affected by the warning.

IMMEDIATE DANGERS



- The immediate threat from tornados is danger to life and damage to property from violently whirling winds and debris hurled through the air by the winds.

LONG-TERM DANGERS

- Long-term risks include the possibility of building collapse, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may be damaged or destroyed.

MITIGATION

- Follow relevant building code practices such as the use of wind-resistant design.

PREPAREDNESS

- The best preparation for a tornado is to designate a safe place in or around your home as a tornado shelter. Tornado shelters are safest if they are underground. A storm cellar or basement away from windows offers the best protection.
- If neither of these is available, plan to find shelter under heavy furniture or mattresses near an inside wall of your house on the ground floor. Get under solid furniture or cover yourself with mattresses pulled off the bed.
- Plan tornado drills with your family so everyone knows what to do.
- Know the location of the designated shelter where you work or go to school.
- Plan to evacuate your manufactured (mobile) home.
- Make an inventory of your household furnishings and other possessions. Supplement the written inventory with photographs or video. Keep inventories and pictures in a safe deposit box or some other safe place away from the premises.

RESPONSE

- If you have a storm cellar or shelter, go to it immediately with your family. If no shelter is available, go to your basement and get under a heavy work bench or stairs. Do not position yourself directly underneath heavy appliances on the floor above you.
- If your home has no basement, stay in the center of the house away from the windows or in a small room on the ground floor that is away from outside walls. Take cover under solid furniture or mattresses. Protect your head.

TORNADO (continued)

- In mobile homes or vehicles, leave and take shelter in a substantial structure. If there is no nearby shelter, lie flat in the nearest ditch or ravine with your hands shielding your head.
- In any large building, such as an office or a department store, avoid all large, poorly supported roofs. Go to the basement or to an inner hallway on a lower floor.
- *Do not drive.* You are safer in a home or basement shelter than in a car.
- If you are driving in a city and spot a tornado, get out of your car and go into a nearby building.
- If you are driving in open country, drive at a right angle away from the tornado's path *if you can safely do so.* Do not try to outrun the storm. If you cannot avoid the tornado, get out of your car. Lie flat in the nearest depression, such as a ditch, culvert, or ravine. Protect your head, and stay low to the ground.

RECOVERY

- After a tornado passes, keep tuned to the local radio or TV station to get an all-clear signal before leaving your shelter. Sometimes more than one tornado will develop during a violent storm.
- Re-enter buildings with extreme caution.
- Be alert to fire hazards such as broken electrical wires or damaged electrical equipment, gas or oil leaks, or smoldering piles of wet hay or feed. Report broken utility lines to appropriate authorities.
- Have damage to your property assessed by your insurance company.

RELATED EMERGENCIES

Tornados are part of a severe thunderstorm and bring with them the dangers of *lightning, high winds, floods,* and *flash floods* from extremely heavy rainfall.

Hurricanes can strike coastal areas from Texas to Maine, Hawaii, Puerto Rico, the Pacific territories, and the Virgin Islands. A hurricane begins as a tropical depression (a low pressure center); if conditions are right, a tropical storm may develop and strengthen until it becomes a hurricane. The term *hurricane* is used when winds reach constant speeds of 74 miles per hour or more. These winds blow in a large spiral around a relatively calm center known as the *eye* of the hurricane. Around the rim of the eye, winds may gust to more than 200 miles per hour. The entire storm dominates the ocean surface and the lower atmosphere over tens of thousands of square miles. In the western Pacific, hurricanes are called *typhoons*. South of the equator and in the Indian Ocean, they are called *cyclones*.

One of the greatest dangers associated with hurricanes is what is known as a *storm surge.* The storm surge is a dome of water, often 50 miles wide, that may flood the coastline near the area where the eye of the hurricane makes landfall. This surge of water may cause flooding up to 20 feet above normal sea level and is topped by battering waves and incredibly strong winds. Nine out of 10 hurricane-related fatalities are caused by the storm surge.

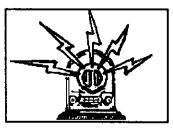
On the average, six Atlantic hurricanes occur each year. Most occur in August, September, and October, but the six-month period from June 1 to November 30 is considered the Atlantic hurricane season. Not all of these violent storms strike land, but when they do the destruction to coastlines and islands in their paths can be tremendous. The worst such recorded event happened in Galveston, Texas, in 1900, when 6,000 lives were lost. The greatest economic damage resulted from Hurricane Hugo in 1989, with an estimated loss of $10 billion.

Not only coastal areas are affected by hurricanes. Hurricane Diana, in 1955, caused little damage as it moved inland, but long after its winds subsided, it brought floods to Pennsylvania, New York, and New England that killed 200 persons and caused an estimated $700 million in damage. In 1972, Hurricane Agnes fused with another storm system, causing more than a foot of rain to fall in less than 12 hours, resulting in severe flooding from Virginia to New England. That hurricane killed 117 people and caused $4.7 billion in damage.

Communities in areas that may be threatened by hurricanes should develop plans for action that specify what areas would be likely to be evacuated and by what routes, what shelters would be used, and how local emergency forces and public service units would respond. Once the plan is in place, the community should conduct exercises (simulations of emergency situations) to determine whether planned procedures are effective and everyone prepared to execute them.

To help communities prepare to help special populations, FEMA publishes *Action Guidelines for Senior Citizens and School Children.* See the Resource section, page R-2, for ordering information.

SIGNS AND WARNINGS



- As a hurricane approaches, the skies will gradually darken over the ocean or gulf, and winds will continue to grow in velocity. The barometric pressure will fall, winds will increase, and rain will fall in torrents.

HURRICANE (continued)

- The National Hurricane Center in Miami monitors weather data and will issue forecasts for hurricanes in the Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and the eastern Pacific Ocean. Your local National Weather Service office, as well as local and State officials, may disseminate hurricane information.

- Learn the terminology used to convey hurricane emergency information.
  - A *hurricane advisory* tells where the storm is located, the intensity of wind speeds, and the direction of movement.
  - A *hurricane watch* is issued for a coastal area when there is a threat of hurricane conditions within 24 to 36 hours. In some more vulnerable areas, actions for protection of life and property should begin at this point.
  - A *hurricane warning* is issued when hurricane conditions are expected in a specified coastal area in 24 hours or less. Hurricane conditions include winds of 74 miles an hour (64 knots) and/or dangerously high tides and waves. Final actions for protection of life and property should be completed as quickly as possible before high winds and heavy rains arrive.

IMMEDIATE DANGERS

- The storm surge can destroy property along a coastline and is the major threat to life. Dangers associated with a hurricane emergency include extremely high winds that can demolish houses, uproot trees, and fill the air with debris. Tornados may develop as a hurricane passes.

LONG-TERM DANGERS

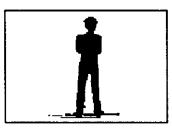
- Long-term hazards come in the form of interrupted gas, water, and electric power, fires and explosions from gas leaks, fallen power lines, electrical short circuits, and contaminated food and water.

MITIGATION

- Retrofit your home to withstand wind and flooding. Coastal homes in flood hazard areas should be elevated. All windows should be shuttered, and structural connectors reinforced. Unreinforced masonry should be strengthened. Consult FEMA's *Coastal Construction Manual* (FEMA-55) for guidance (see page R-1).

- Support the adoption and enforcement of floodplain management requirements.

- In addition to your property insurance, buy a flood insurance policy from your insurance agent. Renters also can buy a flood policy for personal property.



PREPAREDNESS

- Learn about hurricanes—the warnings, the dangers, and how to protect your property, your family, and yourself.

- Be prepared as each hurricane season begins. Every June, recheck your window shutters and supply of boards, tools, batteries, nonperishable foods, bottled water, and other equipment needed to ensure your safety.

- Plan a flood-free evacuation route if your area is vulnerable to flooding or if you live in a mobile home.

- Notify your local emergency manager if you do not have transportation.

- Make a household inventory with pictures or a video, and keep it with your insurance policies in a safe place such as a safety deposit box.

RESPONSE

- When your area receives a hurricane watch, keep calm; plan your time before the storm arrives and avoid a last-minute rush that might leave you marooned or unprepared. Take the following precautions.
  - Listen for weather updates.
  - Moor your boat securely, or move it to a designated safe area.
  - Board up your windows, or protect them with shutters or tape to reduce danger from wind-driven debris and high wind pressure.
  - Secure outdoor objects such as tools, porch furniture, garbage cans, and bicycles that could become deadly projectiles in hurricane winds. Store them inside if possible.
  - Store drinking water in clean bathtubs, bottles, and pans. Ensure batteries are fresh and in sufficient quantity.
  - Keep your car's gas tank filled during a hurricane watch. Service stations may be closed for several days after a hurricane, due to power outages and flooding.

- Manufactured (mobile) homes are extremely susceptible to high winds and should be evacuated for more substantial shelter.

- Evacuate low-lying areas when ordered by officials, and turn off utilities at the main switch, if time permits.

- Stay at home only if it is safe to do so. If you are advised to evacuate, follow directions of local officials.

- When a hurricane strikes, stay indoors away from windows.

- Travel is extremely dangerous during high winds and storm surges. Do not attempt to travel by car or foot once high winds reach your area.

- If the storm center passes directly overhead, the wind will calm down for a period lasting from a few minutes to half an hour or more. Do not be fooled into thinking the hurricane has passed while the eye is over your area. Many people lose their lives by making this mistake. When the winds begin again, they will grow rapidly to hurricane force, and come from the opposite direction.

- Severe flooding may follow hurricanes as they move inland. Stay away from river banks and streams. Monitor National Weather Service advisories on flood stages.

RECOVERY

- If you evacuated, return home when authorities tell you it is safe. Before entering,

HURRICANE (continued)

be sure the structure is safe to enter.

- Call your insurance agent and take pictures of damage to your house and its contents. Hose down hard goods such as major appliances and furniture, even if they are destroyed. You need to keep these for the adjuster's inspection. The adjuster will help you make decisions on whether to repair possessions or replace them.
- Throw out perishable or water-contaminated foods.
- Avoid loose or dangling wires, and report them to the power company.
- Report broken sewer or water mains to the water department.
- Check for gas leaks, and do not strike a match or relight appliances until they have been inspected.
- Open windows and doors to let the air circulate. This will help remove foul odors and protect you from escaping gas. It also will help dry out the house.
- Pump out the basement if it is flooded, but do it gradually. Drain one-third of the flood waters each day, to minimize further structure damage. Shovel out the mud while it is still moist, and dry rugs and carpets thoroughly.
- Make any temporary repairs necessary to prevent further losses.
- Assure that substantially damaged structures are elevated above the base flood elevation when reconstructed.

RELATED EMERGENCIES

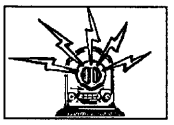
Hurricanes can be accompanied by other severe storm hazards such as *lightning, tornados,* and *flooding.*

Winter storms **vary in size and strength. A storm may be large enough to affect many States or only a portion of a single State. There are three categories of winter storms.**

A *blizzard* is the most dangerous of all winter storms. It combines low temperatures, heavy snowfall, and high winds that blow the snow into drifts and reduce visibility to only a few yards.

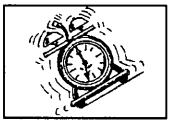
A *heavy snowstorm* is one that drops four or more inches of snow in a 12-hour period, or six or more inches in a 24-hour period. Again, high winds may accompany the storm, blowing the snow into drifts and causing poor visibility.

An *ice storm* occurs when moisture falls from clouds and freezes immediately upon impact. This type of storm makes driving and even walking extremely hazardous.



SIGNS AND WARNINGS

- The National Weather Service issues watches and warnings for hazardous winter weather. Keep informed by listening to weather forecasts on radio or TV and reading local newspapers. Know the terms used to describe storm status.
  - *Winter storm watch* — Severe winter weather may affect your area.
  - *Winter storm warning* — Severe winter weather conditions are expected.
  - *Ice storm warning* — Significant, possibly damaging, ice accumulation is expected.
  - *Heavy snow warning* — A snowfall of at least four inches in 12 hours or six inches in 24 hours is expected.
  - *Blizzard warning* — Large amounts of falling or blowing snow and winds of at least 35 miles per hour are expected for several hours.
  - *Severe blizzard warning* — Considerable falling or blowing snow, winds of at least 45 miles per hour, and temperatures of 10 degrees Fahrenheit or lower are expected for several hours.
  - *High wind warning* — Winds of at least 40 miles per hour are expected to last at least one hour.
  - *Travelers' advisory* — Ice and snow are expected to hinder travel, but the anticipated weather conditions are not serious enough to require warnings.



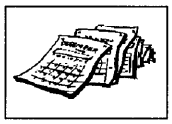
IMMEDIATE DANGERS

- Heavy snowfall and blizzards can trap motorists in their cars, cause major traffic accidents, and trap people in their homes.
- Ice storms can break power lines, causing widespread blackouts.
- Fire during winter storms presents a great danger because water supplies may freeze and firefighting equipment may not be able to get to the fire.
- One of the more serious dangers accompanying any winter storm is the threat of

WINTER STORM (continued)

physical overexertion that can lead to heart attacks and strokes. While this occurs more often among older people, younger individuals also should take precautions.

LONG-TERM DANGERS



- If the storm lasts more than one or two days, there is a greatly increased possibility of utility failures and interruption of services. This can lead to extreme hardship and even death from extended exposure to cold temperatures.

MITIGATION

- Purchase a flood insurance policy to cover possible flood damage that may occur during the spring thaw.

PREPAREDNESS

- Be prepared for isolation at home, particularly if you live in a rural area. It is highly possible that a severe winter storm could isolate you for one or two weeks.
- Insulate your home so you will be able to conserve heat better.
- Use your radio, television, and newspapers to keep informed of current weather conditions in your area. You can better understand weather predictions by knowing the different types of winter storms. Knowledge of weather predictions will also help you to prepare better for the storm before it hits.
- Have fuel and a safe type of emergency heating equipment available in case of power failures that would shut down standard furnaces. A camp stove with fuel or a supply of wood or coal for your fireplace could be used for emergency heat. Be prepared to keep at least one room of your house warm enough to live in for a week or two.
- Be sure that all family members know how to use your emergency heating and lighting equipment safely to prevent fires or dangerous fumes. Proper ventilation is essential. Never use fuel in equipment that was not designed for that fuel. Burning charcoal will give off deadly amounts of carbon monoxide. Burning it indoors, even in a fireplace, is dangerous.
- Stock an emergency supply of food and water. It is more practical to have some foods that do not require cooking or other preparation.
- Should a power failure occur, have a battery-powered radio and extra batteries on hand so you can listen to weather forecasts, emergency information, and other advice broadcast by local authorities. Also, have flashlights, lanterns, candles, and matches ready for use.
- Always have on hand simple tools and other equipment needed to fight a small fire. Winter storms may interrupt fire department services.
- Keep your car winterized with antifreeze. Carry a winter car kit that includes food and water, a windshield scraper, a flashlight, a tow chain or rope, a shovel, tire

chains, a blanket, a bag of sand or salt, a fluorescent distress flag, and an emergency flare, in case you are trapped in a winter storm. Keep extra mittens, hats, and outerwear in the car.

RESPONSE

- Do not be fooled if a winter storm seems mild as it begins. Some storms may take several hours to move into an area and may last for several days.

- Cold weather itself, without any physical exertion, puts an extra strain on your heart. If strenuous physical activity such as shoveling snow, pushing a car, or even walking fast or far through deep snow is added to your body's overworked system, you are risking serious or fatal results. In any cold weather, and especially during winter storms, be aware of this danger and avoid overexertion.

- *Avoid all unnecessary trips.* If you are at home when a winter storm strikes, plan to stay there.

- If you must be outdoors, wear several layers of loose-fitting, lightweight, protective clothing rather than a single layer of thick clothing. Mittens are warmer than gloves. Hoods should be worn to protect your head and face. Cover your mouth to protect your lungs from the extremely cold air.

- If you are travelling and your car breaks down, or if you become stalled or lost, think through the problem, decide what is the safest and best thing to do, and do it slowly and carefully.

- If you are stuck on a well-travelled road, display a trouble signal—turn on your flashing hazard lights, raise the hood of your car, or hang a bright cloth from the antenna or car window.

- Stay in your car and wait for help. Do not leave your car to search for assistance unless you are absolutely certain you can find help within one hundred yards of your car. It is very easy to become disoriented and lost during a severe storm.

- While in your car awaiting assistance, take the following precautions.
  - If you run your engine to keep warm, remember to keep snow away from the exhaust pipe. Keep a window open slightly to provide proper ventilation and protection from carbon monoxide poisoning.
  - Do not let everyone in the car sleep at the same time.
  - At night, turn on the inside dome light so work crews can spot you.

RECOVERY

- After the storm, check on the neighbors in your immediate area. Be sure they have proper heating and sufficient supplies to get them through the emergency.

- Check roofs for damage from heavy snow.

- Avoid overexertion while clearing snow by working slowly and taking frequent breaks, particularly if you become dizzy or tired.

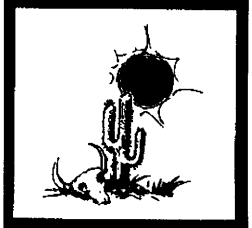
WINTER STORM
(continued)

RELATED EMERGENCIES

Keep in mind that large amounts of snow can lead to localized *flooding* if warmer temperatures melt the snow in a short period of time.

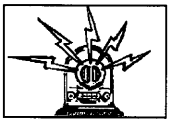
A *drought* occurs when there is no substantial rainfall for a long period of time. Since different sections of the country receive widely differing amounts of rainfall, the amount of time it takes for drought conditions to develop differs throughout the country.

***Extreme heat* is defined as temperatures 10 degrees or more above the average high temperature, lasting for several weeks. Because of differences in the average temperature of different sections of the country and at different times of the year, extreme heat conditions vary. When drought and extreme heat occur at the same time, the conditions can be very dangerous.**



Natural Hazard: DROUGHT AND EXTREME HEAT

SIGNS AND WARNINGS



Local community officials will alert you through your local newspaper, radio station, or television station when drought and extreme heat conditions exist in your area. Although extreme heat conditions are easily recognized, drought conditions develop so slowly that it is recommended that you keep track of local weather advisories so you can take proper action as drought conditions become more likely.

IMMEDIATE DANGERS

There are three stages of danger from extreme heat.

- *Strain* — Occurs when hot weather and/or exertion threaten to raise your body core temperature above 99¡ Fahrenheit.
- *Impairment* — Occurs when your body temperature approaches 102¡ Fahrenheit, creating an abnormal internal state that disrupts normal physical and mental functions.
- *Emergencies* — When heat strain from overexposure lasts too long or becomes too severe, collapse from water depletion, heatstroke, or heart attack may occur.

LONG-TERM DANGERS

A prolonged drought can have serious economic impact on a community. Agricultural production can be damaged or destroyed by loss of crops or livestock, resulting in food shortages. Increased demand for water and electricity can result in shortages of these resources. When combined with extreme heat, droughts can make life very difficult, especially if the situation lasts for a long time.

MITIGATION

- Practice personal water conservation measures to avoid depletion of water supplies both before and during periods of extended drought. An example of a water conservation measure is to place a brick, or other large, solid object, in the flush tank of your toilet. This reduces the amount of water used in flushing.
- If you are a farmer, consider establishing alternative sources and supplies of water.
- Conserve electricity. During periods of heat and drought, people use a lot of power

DROUGHT AND EXTREME HEAT (continued)

for air conditioning. Excessive drain on the community's energy supply could lead to another emergency, such as a power shortage or outage. Insulating your home will reduce the demand for air conditioning; keeping the thermostat set to 78¡F will also reduce energy use.

PREPAREDNESS

- All family members should learn to recognize heat impairment symptoms and administer appropriate first aid.

HEAT DISORDER	SYMPTOMS	FIRST AID
Sunburn	Redness and pain. In severe cases swelling of skin, blisters, fever, headaches.	Ointments for mild cases if blisters appear and do not break. If breaking occurs, apply sterile dressing. Serious, extensive cases should be seen by a physician.
Heat cramps	Painful spasms usually in muscles of legs and abdomen. Heavy sweating.	Firm pressure on cramping muscles, or gentle massage to relieve spasm. Give sips of water. If nausea occurs, discontinue use.
Heat exhaustion	Heavy sweating, weakness, skin cold, pale, and clammy. Pulse thready. Normal temperature possible. Fainting and vomiting.	Get victim out of sun. Lay down and loosen clothing. Apply cool, wet cloths. Fan or move victim to air conditioned room. Give sips of water. If nausea occurs, discontinue use. If vomiting continues, seek immediate medical attention.
Heat stroke (or sunstroke)	High body temperature (106¡F or higher). Hot dry skin. Rapid and strong pulse. Possible unconsciousness.	HEAT STROKE IS A SEVERE MEDICAL EMERGENCY. SUMMON EMERGENCY MEDICAL ASSISTANCE OR GET THE VICTIM TO A HOSPITAL IMMEDIATELY. DELAY CAN BE FATAL. Move the victim to a cooler environment. Reduce body temperature with cold bath or sponging. Use extreme caution. Remove clothing, use fans and air conditioners. If temperature rises again repeat process. Do not give fluids.

For more information, enroll in a First Aid course through your local Red Cross.

RESPONSE

Extreme Heat

- During periods of extreme heat, limit your heat exposure by wearing loose-fitting, porous clothing, and a hat with a wide brim.
- While in direct sunlight, keep as much of your skin covered as possible and use a sunscreen lotion with a rating of 15 or above. Sunburned skin cannot sweat.
- Pace yourself while working. Begin at a very slow pace and continue until you achieve normal pulse and breathing rates at your working level. Do not exceed this pace.
- Replace sweat by drinking water to keep the body fluid volume and salt level as close to normal as possible. Although beer and other alcoholic beverages appear to satisfy thirst, they cause further dehydration of your body.
- Check with your physician to see if you should take additional salt during times of heat.

- Rest regularly. This allows your natural *cooling system* to work. A few minutes of sweat-free rest every hour will help restore physical and mental energy. Soaking hands or feet in cool water also will help lower your body temperature.

Drought

- Curtail all non-essential water uses. Watering your lawn and washing your car are not essential to your well-being.
- Re-use water whenever possible.

RECOVERY

- Continue to conserve water ever after the drought appears to have ended.
- If you own a farm and your crop is lost, contact the county Farmers' Home Administration Office for disaster assistance information.

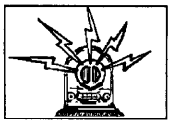
RELATED EMERGENCIES

Keep in mind that drought conditions, with or without extreme heat, can greatly increase the risk of *forest fires.* As the forest dries up, debris on the forest floor, as well as the trees themselves, become prone to fire, even from the slightest spark. The loss of vegetation in the absence of sufficient water can result in flooding, even from average rainfall, following drought conditions.

Natural Hazard:
WILDFIRE

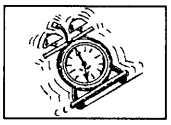
A *wildfire* is any instance of uncontrolled burning in grasslands, brush, or woodlands. Wildfires not only destroy property and valuable natural resources, but also threaten lives. Throughout the summer of 1988, the nation followed news of firefighters trying to save America's wildlands and the communities surrounding them. Their tireless defense of Yellowstone National Park was tracked daily by national news networks. Although these firefighters protected the world-famous geysers, historic park structures, and gateway towns, the fires still destroyed a million acres of National Forest.

Each year, wildland fires pose an increasing threat to residential America. These fires devastate communities and natural resources, and too often take their toll in the loss of lives. In 1987, 53,000 fires consumed more than two million acres. By October 1988, almost 70,000 fires had claimed more than four million acres. The increase in fires is the result of population growth in rural communities. With more and more people in the wildland/urban interface—where wildlands and structures meet—there is a greater risk of fire starts and fire disasters.



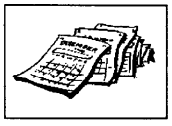
SIGNS AND WARNINGS

- Wildfires can occur at any time of the year, but usually are concentrated during hot, dry weather.
- Wildfires are usually signalled by dense smoke that fills the air for miles around.
- The National Weather Service, U.S. Forest Service, and State forestry agencies combine to give fire weather forecasts. Local radio and TV stations broadcast forecasts and warnings concerning local fire conditions.
- Large forested areas may have watchtowers where spotters look for signs of fires and alert firefighters immediately.



IMMEDIATE DANGERS

- The immediate danger from wildfire is destruction of timber, property, wildlife, and injury or loss of human life. Persons who live in the affected area or who are using recreational facilities in the forested area where the fire breaks out are in danger of being trapped.



LONG-TERM DANGERS

- Wildfires can leave a large amount of scorched and barren land. This land may take many years or decades to return to its pre-fire condition. Major fires can destroy groundcover, which leads to erosion. If heavy rains follow a major fire, flash floods, landslides, and mudflows can occur. Once trees are gone, there is nothing left to hold soil in place or to hold back rainwater or slopes.

MITIGATION

- Use only fire-resistant materials on the exterior of your home, including roof, siding, decking, and trim.

- Use fire carefully and wisely so that you do not cause a fire. Teach family members safe practices.
- Install a spark arrestor on your chimney.
- Keep your chimney clean and avoid open burning during dry weather.
- Store firewood well away from your home.
- Clean roof surfaces and gutters regularly.

PREPAREDNESS

- Learn how to recognize dangerous fire conditions.
- Provide wide spacing between trees. For trees within 100 feet of your house, remove tree limbs within 15-20 feet of the ground or over roofs, and limbs that are above or near a chimney.
- Use fire-resistive plants. Check with local fire officials about the best species for your area.
- Plan several evaluation routes in case fires block your escape.
- Clear an open space around your house to serve as a fire break—at least 30 feet wide for all structures and 75 feet wide for homes built in pine forests.
- Have fire tools handy: a ladder, garden hose, shovel, rake, and bucket.

RESPONSE

- If water sprinklers and adequate water are available, leave sprinklers on roofs and anything else that might be damaged by fire. Be sure that efforts by you and your neighbors to protect your property do not leave firefighters without the huge amounts of water that will be needed to fight the blaze. Place valuables that will not be damaged by water in a pool or pond, or take them with you.
- If officials are evacuating your area, do not hesitate to leave. Fires can spread rapidly and unpredictably.
- If you are on an outing in a forest when a fire breaks out, note the weather conditions and wind direction. Find out the direction of the fire and plan your escape routes in other directions. Evacuate quickly—fires can spread at rapid speeds.
- If you are caught in a wildfire, knowledge of survival techniques could save your life.
  - Look for a nearby body of water and crouch in it, covering your head and upper body with a wet shirt or other article of clothing.
  - Look for a rock outcropping or cleared area to obtain shelter from the fire.
  - If possible, breathe through a wet handkerchief or wet piece of clothing to avoid scorching your lungs or inhaling smoke.
  - Oxygen may be in short supply, so try to remain calm to reduce the rate at which

WILDFIRE (continued)

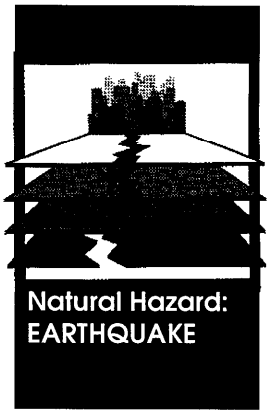
you use oxygen. If possible, breathe the less smoky air close to the ground.
- Do not try to outrun a fire that is burning uphill. Instead, move at right angles to the path of the fire.

RECOVERY

- Care must be taken in reentering burned forest areas. There still may be hot spots that could flare up without warning.
- Replant burned-out forests quickly and efficiently in order to reduce the soil erosion caused by the loss of trees in an area. Ask your State forestry commission for guidelines.
- Consult your insurance agent and have damages assessed as soon as possible.

RELATED EMERGENCIES

Keep in mind that *landslides, mudflows,* and *floods* can occur following a wildfire. Once trees and groundcover have been burned away, there is not much left to hold soil in place on steep slopes and hillsides.



An *earthquake* is a wave-like movement of the earth's surface. The earth's crust and upper part of the mantle are constantly pushing and moving against one another along what are known as fault lines. When rock masses slip along a fault, the energy of an earthquake is released in seismic waves. An earthquake also can be produced by volcanic eruptions. Earthquakes can be extremely violent, but often they are little more than a minor trembling of the ground.

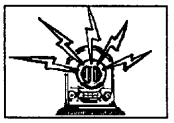
The damage caused by an earthquake depends on its severity or intensity. The most widely known indicator of severity, the Richter scale, measures the energy released when large rock masses in the upper earth suddenly shift. A change of one full point in the Richter scale represents a difference of a factor of about 30 in energy released. Thus, an earthquake of magnitude 7 is roughly 30 times as powerful—in terms of energy released—as one of magnitude 6.

Damage from earthquakes of the same Richter magnitude, however, can vary radically from one location to another because of differences in geological conditions that affect the extent of ground shaking. The rock formations and soil conditions in California, for example, transmit the waves from earthquakes over much smaller regions than those in the eastern parts of the United States.

Today, geologists use what is known as the Modified Mercalli (MM) intensity scale (named after Giuseppe Mercalli, who introduced it in 1902) to measure the intensity of ground shaking at a particular site. The MM scale has 12 gradations. Quakes of intensity I-IV are minor and often are not even noticed. By intensity V nearly everyone senses the movement, and earthquakes of intensity greater than VII are deemed to be major.

One of the most violent earthquakes in the United States occurred in 1964 in Alaska. That earthquake and the tsunami that followed caused more than $100 million in damages and the loss of more than 100 lives. Although the 1989 Loma Prieta Earthquake was of a lower magnitude, it proved to be much more costly in terms of property damage, because it occurred in a heavily populated urban area. Economic damage was estimated at $10 billion.

SIGNS AND WARNINGS



Earthquakes usually occur without warning. If an earthquake is occurring in your area, you will feel a trembling in the ground or floor. You may notice curtains or trees vibrating and swaying.

- Earthquake monitoring is conducted by the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and universities throughout the United States. However, the exact time and place an earthquake will occur still cannot be predicted precisely.

- Earthquakes tend to reoccur along fault lines (fractures in the earth's surface). Though quakes usually strike without warning, scientists have produced risk maps that show areas where an earthquake is likely to occur. Other clues to the probability of a quake come from studying faults, measuring the tilt of the earth's crust, watching changes in the water levels of wells, and even observing the behavior of animals.

EARTHQUAKE (continued)

IMMEDIATE DANGERS

- The actual movement of the ground is seldom the direct cause of death or injury. Earthquake-related casualties are commonly caused by (1) partial or total building collapse, including toppling chimneys or walls, falling ceiling plaster, light fixtures, and pictures; (2) flying glass from broken windows and skylights (this danger may be greater from windows in high-rise structures); (3) overturned bookcases, fixtures, and other large furniture and appliances; (4) fires from broken chimneys and broken gas lines; (5) fallen power lines; and (6) an inappropriate or drastic human reaction caused by fear.

- Fires caused by earthquakes are particularly dangerous. Water mains may be broken and firefighting equipment may be unable to reach the fire. Broken gas lines often are a major cause of earthquake-related fires.

LONG-TERM DANGERS

Earthquakes can cause damage to buildings, utility lines, bridges, or dams. Water supplies can become contaminated by seepage around broken water mains. Damage to roadways and to other means of transportation may create food and other resource shortages if transportation is interrupted.

MITIGATION

- Check your home for potential earthquake and fire risks. Bolt down or reinforce water heaters and other gas appliances, since fire damage can result from broken gas lines and appliance connections. Use flexible connections wherever possible. Place large and heavy objects on lower shelves, and securely fasten shelves to walls. Brace-anchor all tall or top-heavy objects.

- Affix tabletop equipment (such as computers or typewriters) with industrial strength velcro. Overhead lighting fixtures should be anchored solidly in place. A little extra wire is usually all that is necessary.

- Deep plaster cracks in ceilings and foundations should be investigated and repaired by experts, especially if there are signs of structural defects.

- Be sure the house is firmly anchored to its foundation.

- Purchase earthquake insurance.

- Support local safe land use and building codes that regulate land use along fault lines. Insist on code inspection and enforcement in areas where damaging earthquakes can be expected. Modern engineering can produce structures that resist earthquake damage much better than older masonry buildings, and existing buildings can be "retrofitted" to better withstand tremors. If you live in a high-risk area where no such regulations or codes exist, you should support their enactment.

Consider the consequences of an earthquake to your child's school, local hospitals, businesses, and your home. How safe are your community and its buildings?

PREPAREDNESS

- Provide your family with the knowledge of how to protect themselves during an earthquake. Conduct calm family discussions about earthquakes and other possible disasters. Do not tell frightening stories about disasters. Be prepared to survive for 72 hours without any assistance, even from local resources.

- Help organize and support earthquake preparedness programs in your community. For example, your local emergency management agency, schools, volunteer agencies active in disasters, or civic organizations could hold earthquake drills and public education programs to prepare citizens for when earthquakes occur.

- Teach responsible members of your family how to turn off gas, electricity, and water at main switches and valves. Check with your local utilities offices for instructions.

- Learn how to extinguish small fires and to provide emergency first aid.

- Conduct family earthquake drills. Know where the safest places are at home, work, or school.

- Ensure that batteries are on hand for your radio and for flashlights in the event of power failure.

RESPONSE

Above all, remain calm, try to reassure others, and think through the consequences of any action you take. If you are indoors, stay indoors; if outdoors, stay outdoors.

- If you are *indoors*, take cover under a sturdy piece of furniture (such as a heavy desk, table, or bed) to protect yourself from falling objects such as falling plaster, bricks, light fixtures, high bookcases, china cabinets, shelves, and other furniture that might slide or topple. Stay away from objects that can shatter (such as windows, mirrors, or skylights) and from chimneys. DO NOT run outside—you could be injured by falling objects or live wires. Encourage others to follow your example.

- If you are in a *high-rise building*, do not dash for exits. Stairways may be broken or jammed with people. Power for elevators may fail.

- If you are in a *crowded store or mall*, do not rush for a doorway since many other people may have the same idea. If you must leave the building, choose your exit as carefully as possible.

- If you are *outside*, get away from buildings, walls, utility poles, downed wires, and all other objects that could fall. If possible, move to an open area away from hazards and stay there until the shaking stops.

- If you are in a *car*, stop as quickly as safety permits, but stay in the vehicle until the shaking stops. Avoid bridges, underpasses, and tall buildings.

- Check for injuries and attend to them; seek medical help if necessary.

EARTHQUAKE (continued)

- Check for fires or fire hazards.

RECOVERY

- If you are unsure of a building's safety, do not enter until it has been inspected by a qualified person.
- Check utilities. Earth movements may have broken gas, electrical, and water lines. If you smell gas, open windows and shut off the main gas valve. Shut off electrical power if there is damage to your house wiring. Leave the building and report damage to the appropriate utility companies; follow their instructions. Do not use matches, lighters, or open-flame appliances until you are sure there are no gas leaks. Do not operate electrical switches on appliances if gas leaks are suspected.
- Do not eat or drink from open containers near shattered glass.
- Immediately clean up spilled medicines and potentially harmful materials.
- Check to be sure that sewage lines are intact before permitting toilets to be flushed.
- Do not use your telephone except for genuine emergency calls. Turn on your battery-operated radio for damage reports and information.
- Check closets and all storage shelf areas. Open closet and cupboard doors carefully, watching for objects falling from the shelves.
- Check your chimney over its entire length for cracks and damage. First check from a distance, and then move closer if it appears to be safe. Check particularly in the attic and at the roofline. Unnoticed damage could lead to a fire. Always approach chimneys with extreme caution.
- Be prepared for additional earthquake shocks (called aftershocks). While the aftershocks are usually smaller than the main shock, some may be large enough to cause additional damage.
- Have damage to your home assessed by your property insurance claims adjuster.
- Do not go sightseeing; stay away from beach and waterfront areas where seismic sea waves (tsunamis) may strike. Keep the streets clear for passage of emergency vehicles. Stay out of severely damaged buildings. Aftershocks can shake them down.
- Execute repairs that will increase the structure's ability to withstand future quakes.

RELATED EMERGENCIES

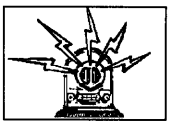
Keep in mind that natural disasters, such as earthquakes, have the potential to trigger other emergency conditions such as *tsunamis, fires, major landslides, dam failures, power plant ruptures,* and *hazardous materials spills.* Be certain you are prepared for all of these disasters if you live in an earthquake-prone area.

A *tsunami* (pronounced "soo na' mee") is a series of giant ocean waves produced by a major underwater or coastline disturbance such as an earthquake or volcanic eruption. A series of waves sometimes lasts several hours, with 20 or 30 minutes between waves. Tsunamis can occur in all oceans, but they are most common in the Pacific. In this century, more than 200 tsunamis have been recorded in the Pacific. Areas thousands of miles from where an earthquake occurs can be struck by a resulting tsunami. A tsunami can travel at speeds of up to 500 miles per hour. The waves appear to be normal ocean waves until they approach the coastline, where a gigantic wall of water can build on the ocean surface. Tsunamis reaching heights of more than 100 feet have been recorded. Traveling at tremendous speeds, these waves smash into land with great destructive power.

On April 1, 1946, a tsunami with wave heights of 55 feet above sea level struck Hawaii, killing 173 people and causing property damage estimated at $26 million. Generated by an earthquake near the Aleutian Islands in Alaska, the tsunami traveled from the Aleutians at about 490 miles per hour, with a wave length of about 100 miles.

A tsunami following the Prince Rupert Sound (Alaska) Earthquake in 1964 directly affected the three West Coast States and Alaska, resulting in 122 deaths and damage totaling $96 million. Hawaii also was affected, but damages were significantly lower. Tsunami-generated waves of 20 feet crashed ashore at Crescent City, California, and waves ranging from 10 to 16 feet occurred along parts of other coastal areas of California, Oregon, and Washington.

SIGNS AND WARNINGS



- If you live near a coastal area and have experienced or heard of a recent earthquake or volcano, listen to your radio for a tsunami warning. The Pacific Tsunami Warning System in Honolulu issues tsunami warnings to affected coastal areas.

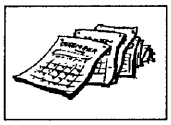
- Tsunamis can be detected before they strike land. If you hear of a tsunami warning, do not go down to the beach to look for the tsunami. If you can see it, you will be too close to escape it.

- Approaching tsunamis usually are preceded by a pronounced rise or fall of coastal water. This action is nature's tsunami warning and should be heeded. Many people have been trapped while exploring the newly uncovered sea bottom in the aftermath of a rapid retreat of ocean water beyond the normal low-tide line.

- The Pacific Tsunami Warning System in Honolulu monitors disturbances that could trigger a tsunami. Local warning systems, developed for Alaska and Hawaii, augment the Pacific system. When a tsunami is spotted, it is tracked and a tsunami warning is issued to the threatened area. This warning should be heeded.

- Your community may be warned by radio or television announcements. Local police, fire, or emergency officials may go door-to-door in threatened areas. Outdoor sirens may sound to warn of the dangers.

TSUNAMI (continued)



IMMEDIATE DANGERS

- Immediate dangers from tsunamis are drowning, flooding, and widespread property damage.

LONG-TERM DANGERS

- Associated risks include broken sewage lines, polluted water supplies, damaged gas lines, and downed power lines.

MITIGATION

- The most effective mitigation measure to avoid property damage is not to build or live in buildings within several hundred feet of the Pacific coastline. Even the strongest buildings can be damaged or undermined by a powerful tsunami.
- If you must live in a coastal building, purchase flood insurance to assure that you will be financially protected in the event of a flood-related loss.

PREPAREDNESS

- Plan several escape routes to high ground. Your primary escape route might be damaged or destroyed if a local earthquake strikes. Be prepared to evacuate low-lying coastal areas immediately.
- Learn the warning signs and signals and heed them.
- Stay off the beach during unusual tidal action.

RESPONSE

- Upon hearing an official tsunami warning or detecting signs of a possible tsunami, *move inland to higher ground as quickly as possible.* Tsunamis can travel at such tremendous speeds that any warning must be acted upon immediately.
- Since a tsunami is not a single wave but a series of waves, stay out of dangerous areas until an "all clear" is issued by an authorized official.
- Check for injuries and seek medical help if necessary.

RECOVERY

- If your home, apartment, or business has been damaged, immediately call your insurance agent, who will advise you what to do next.
- Do not use fresh food that has come in contact with flood waters. Have all drinking water tested by your local health department before use; wells should be pumped out and the water tested before drinking.

- Before entering a building *air it out* for several minutes to remove foul odors or escaped gas.

- Upon entering the building, do not use a match or lantern as a source of light because of the danger of gas build-up; use a battery-powered flashlight instead. Check for electrical shorts and live wires. Make certain power is turned off, and do not use any appliances or lights until an electrician has checked your electrical system.

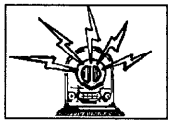
- Open all doors and windows to help the building dry. Shovel out mud while it is still moist to give walls and floors an opportunity to dry.

Natural Hazard: VOLCANIC ERUPTION

Volcanoes **are mountains that have a vent to a reservoir of molten rock (magma) deep below the surface of the earth. Volcanoes form where weak spots or breaks in the earth's crust allow the magma to push toward the surface. When the pressure of gas and magma becomes too great, the volcano erupts. Magma may pour through the vent opening in lava flows or shoot into the air as dense clouds of gas and dust (ashfall).**

In the United States, the chance of eruptions that could damage populated areas is greatest in the active volcanoes of Hawaii and Alaska. Active volcanoes of the Cascade Mountain Range in California, Oregon, and Washington have created dangers. The danger area around a volcano covers approximately a 20-mile radius. Associated dangers may extend 100 miles or more from the volcano.

In 1980, the violent eruption of Mt. St. Helen's resulted in 60 deaths and caused approximately $1.5 billion in damages. The eruption spread thick layers of ash over thousands of square miles and caused massive flooding and mudflows in the immediate area. The Mt. St. Helen's eruption renewed interest in the possibility of future eruptions in the Cascade Range.



SIGNS AND WARNINGS

- A volcano may show signs of erupting weeks or months in advance. Earthquakes, earth tremors, and steam vents around a volcano can signal an eruption.
- Volcanoes can erupt with a force that makes the earth tremble and fills the air with a deafening roar.
- The U.S. Geological Survey assesses all information related to the development of impending geological disasters. They inform the public and appropriate local, State, and Federal authorities. Warnings include information about the approximate time, place, and extent of the effects, as well as the uncertainties involved in making the prediction.
- Communities located near active volcanos should have warning sirens to be sounded if a major eruption occurs.

IMMEDIATE DANGERS

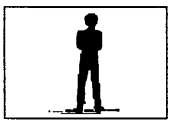
- The degree of hazard to human life and property resulting from a volcano depends upon the type and distance from the eruption. Hazards include lava flows, rockfalls, ashfalls, earthquakes, mudflows, and flash floods.

LONG-TERM DANGERS

- Secondary eruptions and lava flows can occur days, weeks, or months after a volcanic eruption.
- Hazards within the immediate vicinity of the volcano come from heavy ashfall, which can darken the sky as if it were nightfall. The increased demand for electric

lighting could result in power failures. The ash may be carried by winds for thousands of miles and affect distant areas long after the eruption.

- The ash is actually pulverized rock. A one-inch layer weighs ten pounds per square foot. Ash can clog waterways, reservoirs, and machinery, and its weight can cause roofs to collapse.



PREPAREDNESS

- Learn methods of protecting your family and home from ashfall from your local emergency office.
- Have emergency lighting and heating supplies available in case of a power failure.

RESPONSE

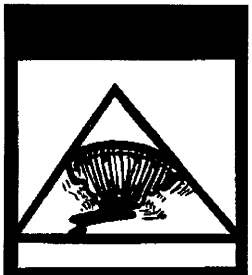
- Heed official warnings of imminent volcanic eruption. If told to evacuate, do so immediately.
- If caught in a small rockfall (not a landslide), roll into a ball and protect your head.
- Immediately following an eruption, flash floods resulting from glacier outbursts can overflow dams and reservoirs. Avoid stream beds and valleys in the vicinity of a volcano. If caught in a low area, run uphill to avoid a flash flood or mudflow.
- During ashfall, close all windows, doors, and dampers in your home. Put all machinery inside a garage or barn. Bring animals and livestock into closed shelters. If ash is falling, stay indoors until the ash has settled.
- If caught outside during ashfall, keep your mouth and nose covered to avoid inhalation of ash. Cover your eyes and keep your skin covered to avoid irritation or burns.
- Do not attempt to drive in heavy ashfall. Driving will stir up more ash and ultimately clog and stall your vehicle.

RECOVERY

- Clear roofs of ashfall as soon as possible to avoid collapse from too much weight.

RELATED EMERGENCIES

Volcanic eruptions can generate mild to moderate *earthquakes, mudflows, flash floods,* and *huge ash clouds*, which can create intense *lightning storms.*



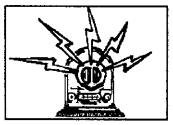
Natural Hazard:
DAM FAILURE

Dams are subject to tremendous amounts of pressure from the water in the reservoirs behind them. *Dam failure* can occur from too much rainfall or melted snow. Earthquakes can weaken or collapse dams. Volcanic eruptions that fill the reservoir with mud and debris, engineering or construction mistakes, inadequate maintenance, or a combination of any of these factors can cause failure. Dams can be weakened by incidents such as burrowing animals and slippage. Flood damage can be caused by events such as floodwater going over the top of the dam. Regardless of the cause, when a dam fails, huge quantities of water rush downstream with great destructive force.

Dam failures in the United States have resulted in thousands of people injured, many killed, and billions of dollars of property damage. Below are some recent examples.

- **1972, Buffalo Creek Dam, West Virginia—125 dead.**
- **1976, Teton Dam, Idaho—14 dead, more than $1 billion in damages.**
- **1977, Laurel Run Dam, Pennsylvania—40 dead.**
- **1977, Kelly Barnes Dam, Georgia—39 dead.**

The U.S. Army Corps of Engineers completed a one-time inspection of operational dams in September 1981. The responsibility to correct problems discovered by the Corps and conduct future inspections rests with the dam owner or the State. Monitoring of new dam construction is the responsibility of the State in which the dam is built. The State may or may not have an effective safety program. Individual communities may press for stricter guidelines and enforcement to enhance dam safety. Additionally, communities should establish land-use management practices to decrease the potential for damage from a collapsed dam.



SIGNS AND WARNINGS

- Your area may have an outdoor warning signal. Warnings may be issued by sirens, horns, radio, television, or door-to-door canvassing by local emergency personnel.
- Federal agencies conduct stream-flow monitoring to provide advanced warning of a flash flood.

IMMEDIATE DANGERS

- The *immediate danger* is the powerful torrent of rushing water that causes injuries, drowning, and property damage from collapsed buildings and bridges.
- The potential for catastrophic loss of life and property damage is great because of the speed and devastating power of such large amounts of rushing water.

LONG-TERM DANGERS

- Associated *risks* include the potential for the spread of disease, animal deaths, and a contaminated water supply. Utility equipment can be damaged, resulting in power outages and possible fires and explosions. Buildings may be dangerously weakened.

MITIGATION

- Before you build or buy a home below a dam, learn as much as you can about its safety record and the safeguards followed by the owners.
- When you build, follow local building codes and take extra measures to reinforce and floodproof your home or building.
- Flood insurance is available through the National Flood Insurance Program. You can buy this insurance coverage through your property insurance agent before an emergency occurs.
- Attend public meetings to learn your area's dam failure preparedness plans.
- Support strong local and State dam safety programs.

PREPAREDNESS

- Learn your community's warning systems.
- If you are in a risk area, plan several alternate evacuation routes to higher ground.

RESPONSE

- If an emergency flash flood warning is issued, *do not hesitate.* Go to higher ground immediately and stay there.
- If you hear the roar of a rushing torrent of water, *get to the highest ground possible.* If you can hear the roar, you may have only seconds to reach safety.
- Stay in your safe spot until the water has subsided or an all clear announcement is made over local media or by a local emergency official.

RECOVERY

- If your home, property, or business has been damaged, immediately call your insurance agent, who will advise you what to do next.
- Do not use food that has come in contact with floodwaters. Have all drinking water tested by local health authorities before using. Wells should be pumped out and the water tested before drinking.
- Avoid loose or dangling electrical wires, and report them to the utility company.
- Report broken sewer lines or water mains to the water department.
- Before entering a building, check for structural damage; make sure it is not in danger of collapsing.
- Open the building and let it air out for several minutes before entering to remove foul odors or escaped gas.
- Upon entering the building, do not use a match or lantern as a source of light because of the possibility of gas buildup; a battery-powered flashlight is recommen-

ded. Check for electrical shorts and live wires. Make certain the power is turned off; do not use appliances or lights until an electrician has checked the electrical system.

- Open all doors and windows to help the building dry. Shovel out mud while it is still moist to give walls and floors an opportunity to dry.

HOW WELL HAVE YOU LEARNED?

Unit Three Review

(Answers on page A-2)

Answer each of the following questions by placing a check next to the *best* response.

1. Which of the following is a long-term danger following a wildfire?
   - ___ a. Tsunami
   - ___ b. Earthquake
   - ___ c. Tornado
   - ___ d. Floods

2. The National Weather Service issues watches and warnings for hazardous winter weather conditions. A *winter storm watch* means that
   - ___ a. Severe winter weather conditions will *definitely* strike your area.
   - ___ b. Snowfall of at least four inches in 12 hours is expected.
   - ___ c. Damaging ice accumulation is expected.
   - ___ d. Severe winter weather conditions may affect your area.

3. Which of the following statements is true about thunderstorms?
   - ___ a. Tornados always occur afterwards.
   - ___ b. Manufactured (mobile) homes are safe places to be in severe storms.
   - ___ c. Several different thunderstorms can affect you in a few hours.

4. Nine out of ten hurricane-related fatalities are caused by
   - ___ a. Tornados.
   - ___ b. High winds.
   - ___ c. A storm surge.
   - ___ d. Downed power lines.

5. The safest response in a flash flood emergency is to
   - ___ a. Take shelter under a heavy piece of furniture.
   - ___ b. Move immediately to higher ground.
   - ___ c. Buy flood insurance.
   - ___ d. Turn off all utilities at the main switch in your house.

6. If you are driving along and spot a tornado, what should you do?
   - ___ a. Pull off the road and remain in the car until the storm passes.
   - ___ b. Attempt to outrun the storm.
   - ___ c. If there is no substantial building nearby to go to, lie flat in a ditch or low-lying area.
   - ___ d. Leave your car and start walking in a direction opposite the storm.